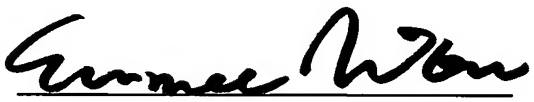
IN THE MATTER OF

U.S. Provisional Application No. **60/477,955**

By Samsung Electronics Co., Ltd

I, Eun-mee Won, an employee of Y.P.LE, MOCK & PARTNERS of The Cheonghwa Bldg., 1571-18 Seocho-dong, Seocho-gu, Seoul, Republic of Korea, hereby declare that I am familiar with the Korean and English language and that I am the translator of U.S. Provisional Application and certify that the following is to the best of my knowledge and belief a true and correct translation.

Signed this 16th day of December 2003



ABSTRACT

[Abstract of the Disclosure]

There are provided a write once disc in which data area management can be performed and a method of managing the data area of the disc. In the write once disc, a lead-in zone, a data area, and a lead-out zone are sequentially formed. The write once disc also includes a predetermined area in which area allocation information, which indicates whether at least one area for disc defect management is allocated to the data area, is recorded. In the disc and method, area allocation information specifying the structure of the data area is recorded on the disc, thus allowing a disc drive to recognize the data area structure. Therefore, it is possible to allocate areas, such as a spare area, other than an area in which user data is recorded, to the data area for disc defect management. Further, bit map information regarding data recording areas is recorded in a predetermined area of the disc, thereby enabling the disc drive to fast access a desired area.

[Representative Drawings]

FIG. 3

SPECIFICATION

[Title of the Invention]

DISC CAPABLE OF MANAGING DATA AREA AND METHOD THEREOF

[Brief Description of the Drawings]

FIG. 1 illustrates structures of a write once disc according to a preferred embodiment of the present invention;

FIG. 2 illustrates a structure of a single record layer disc with spare areas for disc defect management, according to a first embodiment of the present invention;

FIG. 3 illustrates a detailed structure of a Temporary Disc Defect Structure (TDDS) area shown in FIG. 2;

FIG. 4 illustrates a detailed structure of a Space Bit Map (SBM) area of FIG. 2;

FIG. 5 illustrates a structure of a single record layer disc with spare areas for disc defect management, according to a second embodiment of the present invention;

FIG. 6 illustrates a detailed structure of a TDDS + SBM area shown in FIG. 5;

FIG. 7 illustrates a structure of a single record layer disc with spare areas for disc defect management, according to a third embodiment of the present invention;

FIG. 8 illustrates a detailed structure of a Temporary Disc Management Area (TDMA) shown in FIG. 7;

FIG. 9 illustrates a detailed structure of a disc & drive information + SBM area shown in FIG. 7;

FIG. 10 illustrates a structure of a single record layer disc with spare areas and TDMAs for disc defect management, according to a fourth embodiment of the present invention;

FIG. 11 illustrates a detailed structure of a TDMA #1 shown in FIG. 10;

FIG. 12 illustrates a detailed structure of a cluster, shown in FIG. 11, in which both a TDDS and an SBM are recorded;

FIG. 13 illustrates a detailed structure of a cluster containing disc initialization information obtained during disc initialization;

FIG. 14 illustrates a detailed structure of a cluster containing disc re-initialization information;

FIG. 15 illustrates a structure of an SBM area according to a preferred embodiment of the present invention;

FIG. 16 illustrates a finalized SBM area according to a preferred embodiment of the present invention; and

FIG. 17 is a flowchart illustrating a method of managing a spare area of a disc for disc defect management, according to a preferred embodiment of the present invention.

[Detailed Description of the Invention]

[Object of the Invention]

[Technical Field of the Invention and Related Art Prior to the Invention]

Defect management is performed to allow a user to rewrite user data of a portion of a user data area in which a defect occurs to a new portion of the user data area of a disc, thereby compensating for a loss in data caused by the defect. In general, defect management is performed using linear replacement or slipping replacement methods. In the linear replacement method, a user data area in which a defect occurs is replaced with a spare data area having no defects. In the slipping replacement method, a user data area having a defect is slipped to use the next user data area having no defects.

Both linear replacement and slipping replacement methods are applicable only to discs such as a DVD-RAM/RW on which data can be repeatedly recorded and recording can be performed using a random access method.

Meanwhile, methods of disc defect management even on a write once disc on which rewriting of data is not allowed, using the linear replacement method have been developed.

However, there are cases where disc defect management cannot be performed on a write once disc with a disc drive through the linear replacement method. For

instance, when data is recorded on the write once disc in real time, it is difficult to perform disc defect management thereon with the disc drive, using the linear replacement method.

For this reason, a spare area is preferably allocated to a write once disc only when disc defect management using the disc drive is required. That is, the allocation of the spare area is preferably determined by a user's intention.

Also, it is possible to allocate not only spare areas but also other areas for disc defect management to a data area of the write once disc, if necessary.

However, the allocation of other areas, not for user data, to the data area would not allow the disc drive to recognize the structure of the data area.

In other words, if the write once disc contains no information regarding the data area structure, the disc drive is not capable of determining whether other areas for information other than user data are allocated to the data area or not, and determining the position and size of a user data area when the other areas are formed.

After a write operation, information that specifies areas containing data is written in a bit map format to a predetermined area of a disc, thereby enabling facilitation of a further write operation or a read operation.

More specifically, a recordable area of a disc consists of a plurality of clusters that are data recording units or error correction units. If clusters containing data and blank clusters are recorded as information in the bit map format, a recording/reproducing apparatus can readily access a desired area during a write or read operation.

In particular, bit map information specifying areas containing data is very useful when using a write once disc. In other words, it is required to fast detect a cluster next to a cluster in which data is most recently recorded so as to write data to the write once disc. The bit map information enables fast detection of the next cluster.

Also, it is possible to check a change in the recording state of a disc and detect the original data recorded before the change occurs, using the bit map information. The disc recording state may change by recording further data to the disc containing data.

[Technical Goal of the Invention]

The present invention provides a disc on which both user data and other data can be recorded and managed in a data area, and a method of managing the data area.

The present invention also provides a disc whose data recording state can be easily checked.

[Structure of the Invention]

According to an aspect of the present invention, there is provided a write once disc in which a lead-in zone, a data area, and a lead-out zone are sequentially formed, the disc comprising a predetermined area in which area allocation information, which indicates whether at least one area for disc defect management is allocated to the data area, is recorded.

It is preferable that the area allocation information specifies the size of area allocated to the data area.

It is preferable that the disc further comprises a space bit map (SBM) information area in which data recording area information is recorded, and it is more preferable that the data recording area information contains head information and a bitmap that indicates areas containing data.

It is preferable that the head information comprises a finalization flag that indicates whether more data can be recorded on the disc or not.

It is more preferable that the predetermined area in which the area allocation information is recorded is the TDDS area, and the disc further comprises a defect management area (DMA) in which the area allocation information recorded in the TDDS area is copied when the data area does not include an area for disc defect management.

According to another aspect of the present invention, there is provided a method of managing a data area of a write once disc, the method comprising (a) allocating at least one area to the data area of the write once disc for disc defect management, and (b) recording area allocation information, which indicates the allocation of the area for

disc defect management to the data area, in a predetermined area of the write once disc.

It is preferable that the area allocation information specifies the size of the area allocated to the data area.

It is preferable that the method further comprises (c) recording data recording area information, wherein the data recording area information comprises head information and a bit map that indicates areas containing data.

It is preferable that the head information comprises a finalization flag that indicates whether more data can be recorded on the write once disc or not.

It is preferable that (a) comprises (a1) determining whether an area for disc defect management will be allocated to the data area or not, and (a2) when it is determined the area for disc defect management will not be allocated to the data area, recording area allocation information indicating the determination in a predetermined area of the write once disc.

It is more preferable that during (a2), the area allocation information indicating that the area for disc defect management is not allocated to the data area is recorded in a TDMA of the write once disc, and (a) further comprises (a3) recording the area allocation information recorded in the TDMA to a DMA.

Hereinafter, preferred embodiments of the present invention will be described in detail with reference the accompanying drawings.

FIG. 1 illustrates structures of a write once disc (hereinafter referred to as a 'disc') according to a preferred embodiment of the present invention.

(a) of FIG. 1 illustrates a disc that is a single record layer disc having a record layer *L0*. The disc includes a lead-in zone, a data area, and a lead-out zone. The lead-in zone is located in an inner part of the disc and the lead-out zone is located in an outer part of the disc. The data area is present between the lead-in zone and the lead-out zone and is divided into a user data area and a spare area. The spare area has a predetermined size starting from the beginning of the data area.

(b) of FIG. 1 illustrates a disc that is a double record layer disc having two record

layers *L0* and *L1*. A lead-in zone, a data area, and an outer area are sequentially formed from an inner part of the first record layer *L0* to its outer part. Also, an outer area, a data area, and a lead-out zone are sequentially formed from an outer part of the second record layer *L1* to its inner part. Unlike the single record layer disc of FIG. 1(a), the lead-out zone of the second record layer *L1* is present in the inner part of the second record layer *L1*. That is, the disc has an opposite track path (OTP) in which data is recorded starting from the lead-in zone at the inner part of the first record layer *L0* toward the outer part and continuing from the outer area of the second record layer *L1* to the lead-out zone at the inner part. Spare areas are allocated to the first and second record layers *L0* and *L1*, respectively.

In this embodiment, the spare areas are present between the lead-in zone and the user data area and between the outer area and the user data area. However, the positions and numbers of spare areas are not limited.

Initialization of a write once disc according to the present invention will now be described. Disc initialization is a preliminary record operation that is performed prior to use of a disc. More specifically, information regarding the structure of a data area is written to a predetermined area of the disc, thereby enabling a disc drive to recognize the data area structure. The information specifies whether areas, e.g., a spare area, in which data, regarding disc defect management using a disc drive, other than user data is recorded are allocated to a data area, and specifies the positions of the areas allocated to the data area. If disc initialization information, i.e., the information regarding the data area structure, is recorded after the disc initialization, the disc drive is capable of checking the presence and positions of the areas in which information other than the user data is recorded and detecting an area in which the user data is to be recorded.

Hereinafter, embodiments of a disc in which a spare area for disc defect management is formed in a data area, according to the present invention, will be described with reference to FIGs. 2 through 9.

FIG. 2 illustrates a structure of a single record layer disc with spare areas for disc

defect management, according to a first embodiment of the present invention. Referring to FIG. 2, a lead-in zone of the disc includes Defect Management Areas (DMA) *DMA1* and *DMA2*, a recording condition test area, a Temporary Disc Defect Structure (TDDS) area, a Temporary DeFect List (TDFL) area, a space bit map area, and a disc & drive information area.

In general, when a disc is loaded into a disc drive, the disc drive reads information from a lead-in zone and/or a lead-out zone so as to determine as to how to manage the disc and perform a read/write operation. Therefore, if the amount of the information recorded in the lead-in zone and/or the lead-out zone increase, a longer time will be spent preparing the recording or reproducing of the data after loading the disc. To solve this problem, the present invention proposes temporary management information containing a TDDS and a TDFL, the temporary management information being recorded in a TDFL or a TDDS formed, separated from the lead-in zone and/or the lead-out zone.

If no more data will be recorded on the disc, the disc drive begins disc finalization during which recorded TDFL and TDDS are recorded as defect management information in the DMA. Through the disc finalization, only most recently recorded TDFL and TDDS are copied to the DMA. Accordingly, the disc drive can complete disc initialization rapidly by reading only the most recently updated information from the DMA. In this case, the defect management information is stored in a plurality of areas, thereby increasing the reliability of information.

Disc defect management according to this embodiment uses the linear replacement method, and thus, the TDFL specifies an area, i.e., a defective area, of the disc in which a defect occurs, and a replacement area that substitutes for the defective area. More preferably, the TDFL further specifies whether the defective area is a single defective cluster, or a continuous defective cluster in which a series of defects occur physically. The TDDS, which is information for managing the TDFL, specifies the recording position of the TDFL.

The lead-in zone includes the SBM area that contains bit map information

regarding an area containing data, i.e., information regarding a data recordable area.

The data area includes spare areas #1 and #2 and a user data area.

In this embodiment, the spare areas #1 and #2 are formed at the start and end of the data area, respectively, for a case where disc defect management is performed using a disc drive during disc initialisation.

The lead-out zone includes DMAs #3 and #4 and other areas.

When a user determines disc defect management using a disc drive and instructs the disc drive to allocate spare areas in a data area, the disc drive allocates the spare areas #1 and #2 to predetermined portions of the data area, e.g., at the start and end of the data area. Then, the disc drive records area allocation information, which indicates the allocation of the spare areas #1 and #2, in a first cluster of the TDDS. The size of the area allocation information may be equivalent to those of the allocated spare areas #1 and #2. If starting and ending addresses of the spare areas #1 and #2 are determined, for example, the spare areas #1 and #2 are positioned at the start and end of the data area, respectively, the disc drive can recognize the allocation of the spare areas #1 and #2 and their positions and sizes only based on information regarding the spare area sizes.

For this reason, when the starting and ending addresses of the spare areas #1 and #2 are not determined, these addresses are determined and recorded.

In this embodiment, the area allocation information is recorded in the TDDS area but can be recorded in another area.

After recording the area allocation information in the first cluster of the TDDS area, a bit map is recorded in a first cluster of the SBM area, the bit map recording bit corresponding to the positions of the first clusters of the TDDS and the SBM area with 1 and recording bits corresponding to the positions of the other clusters as 0.

If the user does not desire to perform disc defect management using the disc drive, the disc drive records the area allocation information, which indicates the sizes of the spare areas #1 and #2 as 0, in the first cluster of the TDDS area.

After recording the area allocation information in the TDDS area, a bit map,

which indicates the bits corresponding to the positions of the first clusters of the TDDS and the SBM area as 1 and indicates the bit corresponding to the positions of the other clusters as 0, is recorded in the first cluster of the SBM area.

As previously mentioned, it is possible to change the structure of the data area by re-initializing the disc and updating the area allocation information, even if the area allocation information was recorded in the TDDS area and data was recorded on the disc during the previous disc initialisation. Disc re-initialization will be later described with reference to FIG. 14.

When the user does not require disc defect management using the disc drive, no information will be recorded in the DMA. In this case, the area allocation information recorded in the TDDS area is recorded in the DMA even if disc finalization is not being performed.

Meanwhile, a re-writable disc does not include a TDDS area, and thus, it is impossible to reproduce information from a write once disc with a TDDS area containing area allocation information, using a reproducing apparatus for re-writable discs. To solve this problem, information recorded in the TDDS area is copied to a DMA when performing disc finalization on the write once disc.

In other words, if disc defect management using the disc drive will not be performed, the area allocation information recorded in the TDDS area is recorded in the DMA prior to disc finalization, thereby enabling reproduction of information from a write once disc using a re-writable disc reproducing apparatus.

FIG. 3 illustrates a structure of the TDDS area shown in FIG. 2, according to a preferred embodiment of the present invention.

A TDDS is recorded in a cluster of a TDDS area at least once until a recording operation ends. In general, a plurality of TDDS #0, TDDS #1, ... are recorded in the TDDS area. In this embodiment, TDDS #0 is recorded in a cluster of a TDDS area once when a recording operation ends.

Referring to FIG. 3, the TDDS area consists of a plurality of clusters. A cluster is a basic unit of record and consists of sectors of a predetermined number. A sector is

a physical basic unit of a disc.

During disc initialization, when a user determines whether a spare area will be allocated or not, area allocation information indicating the user's determination is recorded in the TDDS #0. The TDDS #0 includes a TDDS identifier, counter information indicating the number of updating the TDDS #0, position information regarding drive information, position information regarding a corresponding TDFL if any, information regarding the size of a spare area #1, and information regarding the size of a spare area #2. As previously described, when the user does not require disc defect management using a disc drive and allocate spare areas in a data area, the sizes of spare areas #1 and #2 are recorded as '0'.

Although a detailed structure of a TDFL area is not illustrated, a TDFL #i contains information regarding defects occurring in data recorded during a recording operation #i and information regarding replacements for the defects. Also, previous TDFLs #0, #1, #2, ..., #i-1 are not accumulated in the TDFL #i and only information regarding defects occurring in a recording area made during the corresponding recording operation #i is recorded in the TDFL #i, thereby minimizing a recording capacity and enabling efficient use of a recording space of a TDDS.

FIG. 4 illustrates a structure of the SBM area shown in FIG. 2, according to a preferred embodiment of the present invention. A SBM area consists of a plurality of clusters and each SBM #i is recorded in a cluster.

Each SBM #i includes an SBM header area and a bit map area. In the SBM header area, SBM identifier information, counter information indicating the number of updating the SBM #i, and a finalization flag are recorded. The finalization flag will be later described.

The bit map area contains a bit map that indicates clusters containing data and blank clusters with different bit values in cluster units with respect to entire recordable areas of a disc.

After recording a TDDS #0, an SBM #0 is recorded in a first cluster of the SBM area. In the bit map of the SBM #0, a bit corresponding to the position of a first cluster

of a TDDS and a bit corresponding to the position of the first cluster are expressed with 1, and bits corresponding to the remaining clusters are expressed with 0.

Accordingly, recording size information regarding spare areas in the TDDS #0 allows a disc drive to check the presence of spare areas and determine the positions or sizes of allocated spare areas. Also, the disc drive is capable of rapidly recognizing an area containing data and a blank area of the disc by recording the SBM #0 after recording the TDDS #0.

In the disc, shown in FIG. 2, according to the first embodiment, a TDDS area, a TDFL area, and an SBM area are individually formed and a TDDS, a TDFL, and an SBM are recorded therein in cluster units, respectively. However, recording of the TDDS and the SBM is not limited to these areas, that is, they may be recorded in different areas.

FIG. 5 illustrates a structure of a single record layer disc in which spare areas for disc defect management are formed, according to a second embodiment of the present invention. In this embodiment, a lead-in zone includes an area in which both a TDDS and an SBM are recorded.

When a user desires to perform disc defect management using a disc drive and instructs the disc drive to allocate spare areas, the disc drive allocates spare areas #1 and #2 at the start and end of a data area in predetermined sizes, respectively.

Then, the disc drive area records allocation information, which indicates the allocation of the spare areas #1 and #2, in first clusters of the TDDS and the SBM.

FIG. 6 illustrates a detailed structure of a TDDS + SBM area shown in FIG. 5. Referring to FIG. 6, a TDDS and an SBM are recorded in a cluster. The TDDS contains size information, i.e., area allocation information, regarding each spare area and the SBM, and the SBM contains a bit map.

After recording the area allocation information in a first cluster of the TDDS + SBM area, the bit map records a bit for the position of the first cluster of the TDDS + SBM area as 1 and bits for the positions of the other clusters as 0.

FIG. 7 illustrates a structure of a single record layer disc in which spare areas for

disc defect management are formed, according to a third embodiment of the present invention. In this embodiment, a lead-in zone includes a Temporary Disc Management Area (TDMA) area in which both a TDFL and a TDDS are recorded, and a disc & drive information + SBM area in which both disc and drive information and an SBM are recorded. That is, the TDFL and TDDS are recorded in a cluster and the disc & drive information and SBM are recorded in a cluster.

Similarly in the first and second embodiments, a user determines disc defect management using a disc drive and instructs the disc drive to allocate spare areas to a data area of a disc. Then, the disc drive allocates spare areas #1 and #2 to the start and end of the data area in predetermined sizes.

Next, the disc drive records area allocation information that indicates the allocation of the spare areas #1 and #2 in a first cluster of the TDMA.

FIG. 8 illustrates a detailed structure of the TDMA shown in FIG. 7. The TDMA consists of clusters in which disc defect management information is recorded. In each cluster, a TDDS and a TDFL are recorded. The TDDS contains information regarding positions spare areas, the information being area allocation information.

FIG. 9 illustrates a detailed structure of the disc & drive information + SBM area shown in FIG. 7, according to a preferred embodiment of the present invention.

Each cluster contains disc & drive information and SBM information. The SBM information contains a bit map.

Information regarding spare areas is recorded in a first cluster of a TDMA. Next, a bit map indicates bits for first clusters of the TDMA and the disc & drive information and SBM area with 1 and bits for the remaining clusters with 0.

FIG. 10 illustrates a structure of a single record layer disc in which spare areas and TDMAs are formed for disc defect management, according to a fourth embodiment of the present invention. Unlike the disc according to the first through third embodiments, the disc of FIG. 10 further includes a TDMA #2 in a data area, in addition to a TDMA #1 in a lead-in zone.

The TDMAs #1 and #2 are different from each other in that updated information is

recorded in the TDMA #1 before ejecting of a disc from a disc drive at latest or during disc initialization, and updated information is recorded in the TDMA #2 in operation units during recording data on the disc. Here, the operation units are units in which a verify-after-write method is facilitated. In the verify-after-write method, data is recorded in cluster units and then verified.

If a TDMA is allocated only to a lead-in zone, the size of the TDMA is limited thus making it difficult to frequently update information. It is possible to reduce the number of updating information by updating a TDDS when ejecting the disc from the disc drive. However, in this case, the updating of the TDDS will be incompletely terminated when supply of power to the disc drive is interrupted due to an unexpected accident, such as a power failure, during a write operation.

To solve this problem, the disc of FIG. 10 further includes the TDMA #2 in the data area. The TDDS is updated and recorded in the TDMA #2 in units in which the verify-after-write method is facilitated, thereby preparing for a failure in updating the TDDS due to the interruption of power supply. After ejecting the disc, final defect information and state information regarding the disc are repeatedly recorded both in the TDMAs #1 and #2, thereby increasing the robustness of information.

The reason for forming the TDMA #2 in the data area is that frequently updating of information in the TDMA #2 requires the TDMA #2 to be spacious. On the other hand, the TDMA #1 is not required to be spacious and thus is formed in the lead-in zone (or a lead-out zone).

If a user does not desire disc defect management using a disc drive or does not require allocation of the TDMA #2 although he or she wants disc defect management during disc initialization, the TDMA #2 will not be allocated to the data area and area allocation information indicating this information is recorded in the TDMA #1.

FIG. 11 illustrates a detailed structure of the TDMA #1 shown in FIG. 10. Referring to FIG. 11, a TDFL, a TDDS, and an SBM are recorded in the TDMA #1. More specifically, both the TDDS and the SBM are recorded in a cluster *TDDS + SBM #k* and the TDFL is recorded in another cluster (k is an integer more than 0). The

TDMA #2 has the same construction as the TDMA #1 and its detailed description will be omitted.

FIG. 12 illustrates a detailed structure of the cluster *TDDS + SBM #k*, shown in FIG. 11, in which both a TDDS and an SBM are recorded. Referring to FIG. 12, the TDDS specifies the positions of a recording condition test area, drive information, a TDFL, spare areas #1 and #2, a TDMA #2, a TDDS + SBM area for another record layer, a TDDS + SBM area for another TDMA.

If the starting and ending addresses of each area of the disc are determined, it is sufficient to describe information regarding the sizes of spare areas #1 and #2 and TDMA #2 as their position information. Otherwise, the position information is indicated with their starting and ending addresses.

If the disc has at least two record layers, an SBM for each record layer is required.

FIG. 13 illustrates a detailed structure of a cluster *TDDS + SBM #0* containing disc initialization information obtained during disc initialization. FIG. 13 illustrates a case where spare areas #1 and #2 and a TDMA #2 are formed in a data area. Referring to FIG. 13, information regarding their sizes is recorded as disc initialization information. In this case, it is understood that their starting and ending addresses have already been determined.

Even if spare areas are allocated to the data area and the disc is initialized by recording area allocation information that indicates the allocation, it is possible to change the structure of the data area by re-initializing the disc and updating the area allocation information.

FIG. 14 illustrates a detailed structure of a cluster *TDDS + SBM #n+1* containing disc re-initialization information. Referring to FIG. 14, information that specifies a change in the sizes of spare areas #1 and #2 and a TDMA #2 is recorded in a TDDS area.

Let us assume that the spare area #1, the TDMA #2, a user data area, and the spare area #2 are sequentially formed in a data area, and defect information is recorded in the spare area #2 starting from a cluster with the largest address to a cluster with the

smallest address. In this case, disc re-initialization is performed to effectively use a recording area between a cluster with the largest address of the user data area and the cluster with the smallest address of the spare area #2.

In other words, the disc re-initialization increases or decreases the size of the spare area #2, thus enabling effect use of the recording area.

Disc re-initialization information is recorded in at least one cluster *TDDS + SBM* belonging to a TDMA #1 or the TDMA #2.

Hereinafter, an SBM that is information regarding a data recording area will be described in greater detail.

FIG. 15 illustrates a structure of an SBM area according to a preferred embodiment of the present invention. Referring to FIG. 15, SBMs #0 through #n which provide data recording area information are recorded in the SBM area. In this embodiment, an SBM #i is recorded in a cluster (i is an integer from 0 to n). However, as illustrated in FIGs. 6 through 9, SBM #i may be recorded together other information in a cluster.

Each SBM #i provides head information containing an SBM descriptor, a finalization flag, and an update counter; and a bit map #i (i is an integer from 0 to n) that indicates recordable areas of entire recording areas of the disc in cluster units.

If data is further recorded on the disc and data recording area information changes, each SBM #i, which contains a new bit map describing data recording areas, is generated and recorded. In this case, the update counter represents the number of updating the data recording area information.

An instant of time when each SBM #i is generated and updated may be differently determined depending on a program installed in a recording apparatus. However, after recording data on the disc, a new SBM #i must be generated and recorded before ejecting the disc from the recording apparatus.

The finalization flag indicates whether the disc is finalized or not.

FIG. 16 illustrates a finalized SBM area according to a preferred embodiment of the present invention. The finalization flag for a head of an SBM is set to 0 and

recorded together with other information. Referring to FIG. 16, an SBM recorded right before disc finalization is an SBM #n. If a finalization command is given from a host such as a computer to a disc drive, the disc drive indicates completion of disc finalization by changing a finalization flag among information regarding the SBM #n, which is last updated, from 0 to 1, and recording the SBM #n again.

If necessary, the disc drive may allow no more SBMs to be recorded by recording data such as "ffh" in an area next to an area containing the SBM #n having the finalization flag '1', thereby preventing additional recording of data on the disc.

A user can maintain the recording state of the disc at an instant of time when disc finalization is performed, based on an SBM having the finalization flag '1'. Even if data recorded on the finalized disc is changed or new data is added to the original data without permission, it is possible to detect the original data recorded during the disc finalization by referring to a bit map contained in the SBM having the finalization flag '1'. Therefore, data that is added after the disc finalization can be easily detected.

It is preferable that an area in which each SBM #i is recorded is positioned in at least one of a data area, a lead-in zone, and a lead-out zone as shown in FIG. 1.

Spare areas and TDMAs are allocated to a data area in the above embodiments but an area to which the spare areas and the TDMAs are allocated and areas allocated to the data area are not limited. For instance, a TDMA area and a TDDS area may be further allocated to the data area. Those ordinary skilled in the art could have derived areas other than these area.

Also, a TDDS area and an SBM area are allocated to a lead-in zone in the above embodiments but may be formed in a data area or a lead-out zone.

Although now shown in drawings, a TDFL area may be formed in the data area. In this case, if a user desires disc defect management using a disc drive, the user allocates a spare area #1, a spare area #2, and the TDFL area and records a TDDS and an SBM as described above. The TDFL may be positioned between the lead-in zone and the spare area #1, between the spare area #1 and a user data area, at the middle of the user data area, between the user data area and the spare area #2, and between

the spare area #2 and a lead-out area,

If the user does not desire disc defect management using the disc drive, the allocation of spare areas is not required. However, if the user records data in real time using disc defect information obtained by scanning a disc, the TDFL area is required to store the disc defect information. Therefore, the TDFL is allocated during disc initialization.

In the above embodiments according to the present invention, management of spare areas and recording of a bit map are described with respect to a single record layer disc. However, the present invention can be applied to a dual record layer disc.

Meanwhile, when a disc according to the present invention is a write once disc, the disc includes a TDMA for disc defect management. However, if the disc is a re-writable disc, the disc includes a DMA but does not include a TDMA. Therefore, a re-writable disc recording/reproducing apparatus is not capable of reproducing/recording data from/on a write once disc with a TDMA, that is, a disc compatibility issue is caused. For a solution to the disc compatibility, a TDFL recorded in a TDDS area is copied to a TDMA prior to finalization of the write once disc.

FIG. 17 is a flowchart illustrating a method of managing a spare area of a disc for disc defect management, according to a preferred embodiment of the present invention.

Before initially recording user data to a write once disc, a user determines whether to allocate spare areas for disc defect management to a data area.

If the user desires to allocate the spare areas to the data area, the user commands a disc drive to allocate the spare areas to predetermined portions of the data area of the write once disc (action 110). Here, the predetermined portions may be the predetermined sized start and end of the data area.

Next, the disc drive records area allocation information, which indicates whether the spare areas are allocated or not, on a predetermined area of the disc (action 130). For instance, the area allocation information may specify the sizes of the allocated spare areas. If the spare areas are formed at the start and end of the data area, the

disc drive can recognize not only the allocation of the spare areas but also their positions and sizes, only based on the size information regarding the spare areas.

The area allocation information may be recorded in a TDDS area that is formed on at least one of a lead-in zone, the data area, and a lead-out zone. Also, a TDDS may be recorded in different areas as illustrated in FIGs. 3, 6, 8, and 12.

After action 130, data recording area information that indicates areas containing data is recorded (action 150). The data recording area information may be an SBM. The SBM includes head information and a bitmap that indicates areas containing data. A bit value of a bit map, which corresponds to the predetermined area containing the area allocation information, is recorded as a predetermined value indicating that the predetermined area is an area containing data, thereby making the bitmap to reflect the area containing new data.

The head information of the SBM includes a finalization flag that represents whether more data can be recorded on the disc. It is possible to check whether there is changes in a disc recording state using a bit map corresponding to the finalization flag 1 and detect the original data before the change occurred.

After disc initialization, the initialized disc can be initialized again by updating area allocation information, thereby changing the structure of the data area.

Further, although not illustrated in the drawings, the size of spare area is determined to be 0 and recorded in a predetermined area, e.g., a TDDS area, when the user does not desire to perform disc defect management using a disc drive and allocate spare areas to the data area.

If the user does not desire disc defect management using the disc drive, no data is recorded in a DMA. Thus, area allocation information recorded in a TDMA is recorded in the DMA regardless of whether disc finalization is being performed or not.

Since a re-writable disc does not include a TDDS area, it is impossible to reproduce data from a write one disc with a TDMA containing area allocation information, using a re-writable disc reproducing apparatus. To solve this problem, information recorded in the TDMA is recorded in the DMA during disc finalization, thereby enabling

disc compatibility.

If disc defect management using the disc drive will not be performed, the area allocation information recorded in the TDMA is recorded in the DMA before disc finalization, thereby enabling reproduction of data from the write once disc using the re-writable disc reproducing apparatus.

In conclusion, it is preferable that whether spare areas will be allocated to a data area is determined and area allocation information is recorded before recording user data on a disc for the first time, i.e., during disc initialization.

In this disclosure, allocation of spare areas to a data area is described but the present invention is not limited to this disclosure. That is, according to the present invention, different areas, such as a TDMA, a TDFL area, and a TDDS area, can be allocated to the data area. Those ordinary skilled in the art could have derived areas other than the above areas.

[Effect of the Invention]

As described above, in a disc in which data area management can be performed and a method of managing a data area of the disc, according to the present invention, area allocation information regarding the structure of the data area is recorded on the disc, thus allowing a disc drive to recognize the data area structure. Therefore, for disc defect management, it is possible to allocate areas, such as a spare area, other than an area in which user data is recorded to the data area, thereby enabling efficient use of the disc.

Also, after disc initialization, it is possible to change the structure of the data area by updating area allocation information through disc re-initialization.

Further, a bit map, which specifies data recording areas, is recorded in a predetermined area of the disc, thereby enabling the disc drive to fast access a desired area. The bit map allows the disc drive to check whether there is a change in a disc recording state and detect data originally recorded before the occurrence of change, the change being occurred by recording additional data to the disc.

What is claimed is:

1. A write once disc in which a lead-in zone, a data area, and a lead-out zone are sequentially formed, the disc comprising a predetermined area in which area allocation information, which indicates whether at least one area for disc defect management is allocated to the data area, is recorded.

2. The disc of claim 1, wherein the area allocation information specifies the size of area allocated to the data area.

3. The disc of claim 1, wherein the area allocated to the data area for disc defect management includes at least one of a spare area, a temporary disc defect structure (TDDS) area, a temporary defect list (TDFL) area, and a temporary defect management area (TDMA).

4. The disc of claim 1, further comprising a space bit map (SBM) information area in which data recording area information is recorded,

wherein the data recording area information contains head information and a bitmap that indicates areas containing data.

5. The disc of claim 4, wherein when the area allocation information is recorded in a predetermined cluster of the predetermined area, a bit of the bit map corresponding to the predetermined cluster is recorded as a predetermined value that indicates the predetermined cluster contains data.

6. The disc of claim 4, wherein the head information comprises a finalization flag that indicates whether more data can be recorded on the disc or not.

7. The disc of claim 1, wherein the predetermined area in which the area allocation information is recorded is the TDDS area.

8. The disc of claim 7, further comprising a defect management area (DMA) in which the area allocation information recorded in the TDDS area is copied when the data area does not include an area for disc defect management.

9. The disc of claim 1, further comprising;

a first temporary defect management area (TDMA) formed in the lead-in zone; and

a second TDMA formed in the data area,

wherein the area allocation information indicates allocation of the second TDMA to the data area, and

the predetermined area in which the area allocation information is recorded is one of the first and second TDMAs.

10. The disc of claim 9, wherein the first TDMA is an area in which an updated TDDS is recorded at least once right before ejecting the disc from a disc drive, and

the second TDMA is an area in which the updated TDDS is recorded in units of predetermined operations during which data is recorded.

11. The disc of claim 1, wherein the area allocation information is recorded in at least one cluster of the predetermined area and updated area allocation information is further recorded in at least one cluster.

12. A method of managing a data area of a write once disc, comprising:

(a) allocating at least one area to the data area of the write once disc for disc defect management; and

(b) recording area allocation information, which indicates the allocation of the area for disc defect management to the data area, in a predetermined area of the

write once disc.

13. The method of claim 12, wherein the area allocation information specifies the size of the area allocated to the data area.

14. The method of claim 12, wherein during (b) the area allocation information is recorded in a TDDS area formed in at least one of a lead-in zone, the data area, and a lead-out zone.

15. The method of claim 15, further comprising (c) recording data recording area information,

wherein the data recording area information comprises head information and a bit map that indicates areas containing data.

16. The method of claim 15, wherein (c) comprising (c1) recording a bit value for the bit map corresponding to a predetermined area that contains data indicating whether the spare area is allocated or not, as a predetermined value indicating an area containing data.

17. The method of claim 15, wherein the head information comprises a finalization flag that indicates whether more data can be recorded on the write once disc or not.

18. The method of claim 12, wherein (a) comprises:

(a1) determining whether an area for disc defect management will be allocated to the data area or not; and

(a2) when it is determined the area for disc defect management will not be allocated to the data area, recording area allocation information indicating the determination in a predetermined area of the write once disc.

19. The method of claim 18, wherein during (a2) the area allocation information indicating that the area for disc defect management is not allocated to the data area is recorded in a TDMA of the write once disc, and

(a) further comprises (a3) recording the area allocation information recorded in the TDMA to a DMA.

20. The method of claim 12, wherein during (a) at least one of a spare area, the TDDS area, a TDFL area, and the TDMA is allocated to the data area.

21. The method of claim 12, wherein during (a) a second TDMA is allocated to the data area, and

during (b) the area allocation information indicating the allocation of the second TDMA to the data area is recorded in one of the first and second TDMAs formed in the lead-in zone.

22. The method of claim 21, wherein the first TDMA is an area in which an updated TDDS is recorded right before ejecting the write once disc from a disc drive, and

the second TDMA is an area in which the updated TDDS is recorded in units of predetermined operations during which data is recorded.

23. The method of claim 12, further comprising (d) updating the area allocation information by recording a change in the area allocation information in the predetermined area.

FIG. 1A

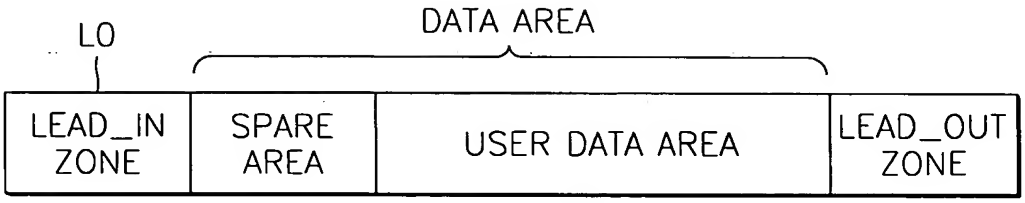

L0
DATA AREA
LEAD_IN ZONE
SPARE AREA
USER DATA AREA
LEAD_OUT ZONE

FIG. 1B

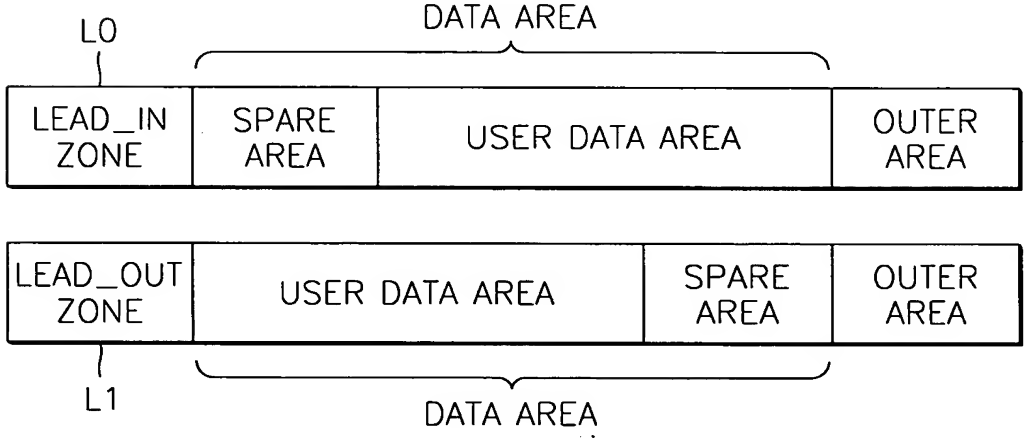

L0
DATA AREA
LEAD_IN ZONE
SPARE AREA
USER DATA AREA
OUTER AREA
LEAD_OUT ZONE
USER DATA AREA
SPARE AREA
OUTER AREA
L1
DATA AREA

FIG. 2

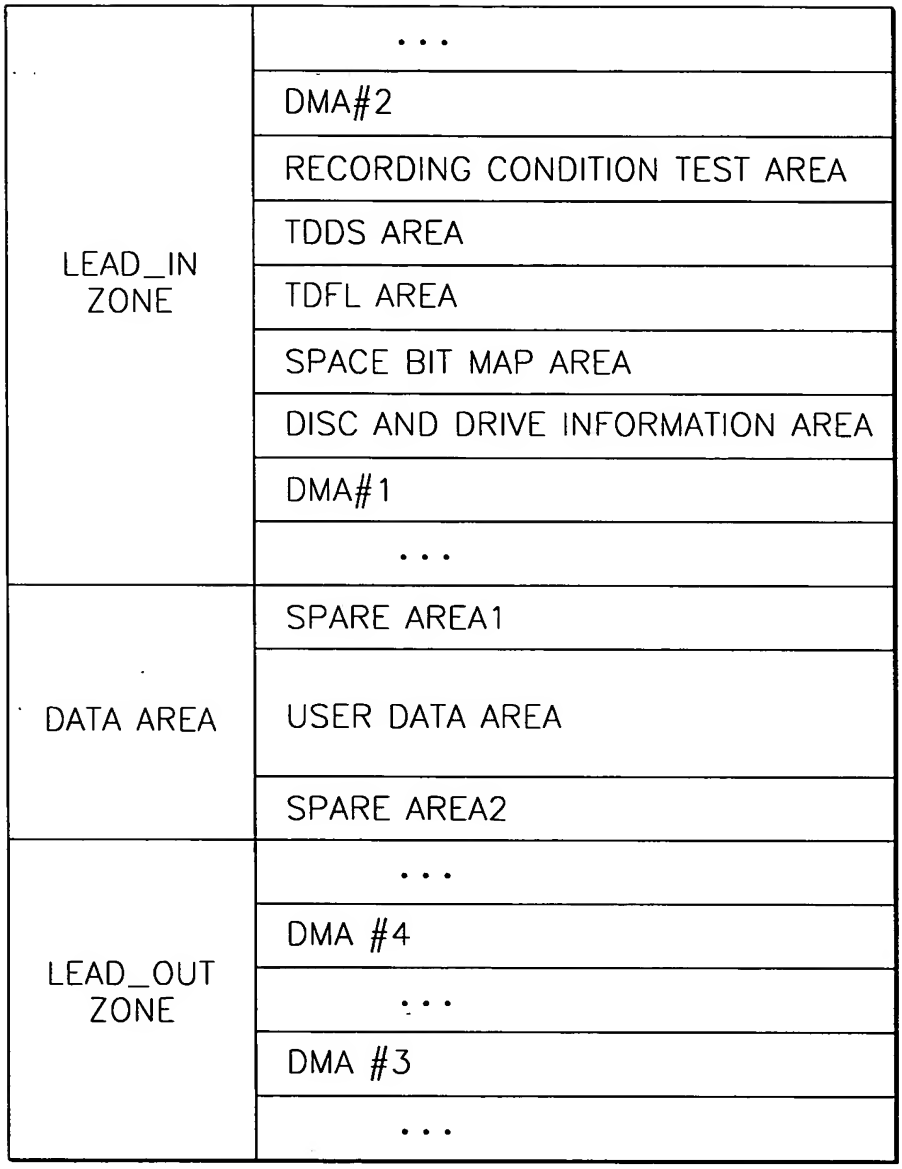

LEAD_IN ZONE
...
DMA#2
RECORDING CONDITION TEST AREA
TDDS AREA
TDFL AREA
SPACE BIT MAP AREA
DISC AND DRIVE INFORMATION AREA
DMA#1
...
DATA AREA
SPARE AREA1
USER DATA AREA
SPARE AREA2
LEAD_OUT ZONE
...
DMA #4
...
DMA #3
...

FIG. 3

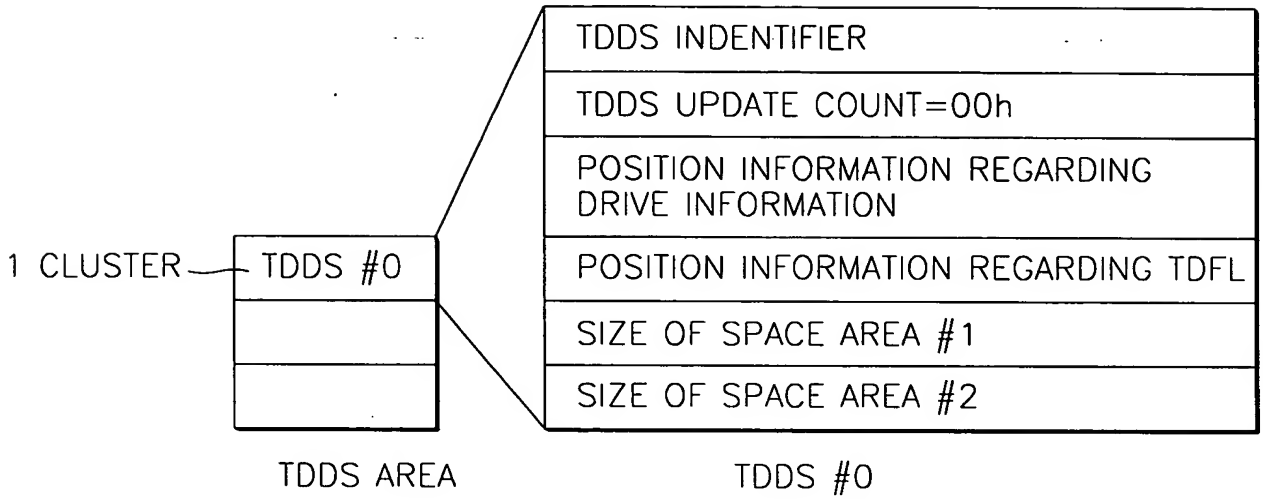

1 CLUSTER
TDDS #0
TDDS AREA
TDDS INDENTIFIER
TDDS UPDATE COUNT=00h
POSITION INFORMATION REGARDING DRIVE INFORMATION
POSITION INFORMATION REGARDING TDFL
SIZE OF SPACE AREA #1
SIZE OF SPACE AREA #2
TDDS #0

FIG. 4

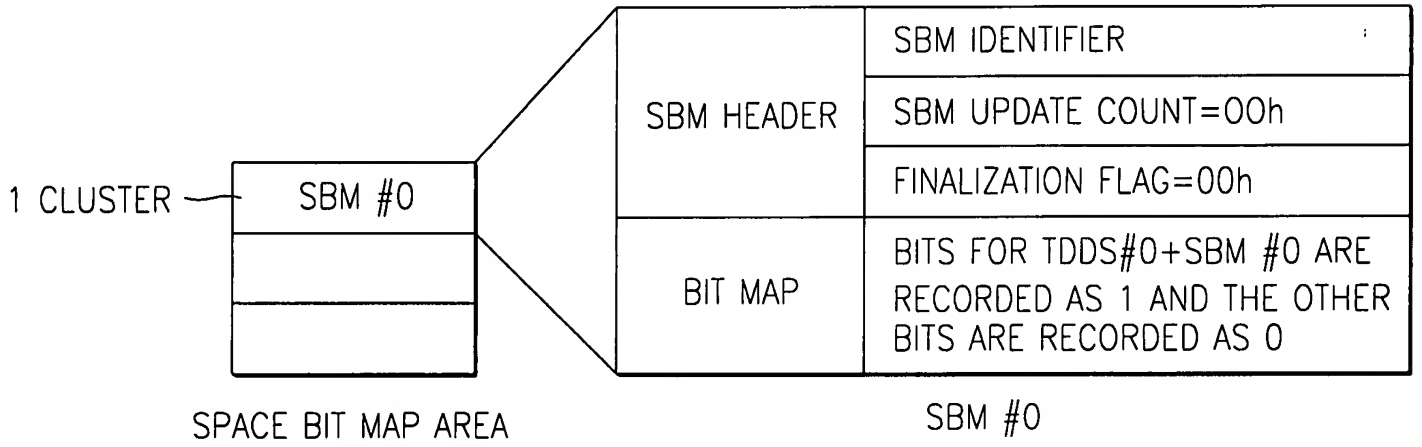

1 CLUSTER
SBM #0
SPACE BIT MAP AREA
SBM HEADER
SBM IDENTIFIER
SBM UPDATE COUNT=00h
FINALIZATION FLAG=00h
BIT MAP
BITS FOR TDDS#0+SBM #0 ARE RECORDED AS 1 AND THE OTHER BITS ARE RECORDED AS 0
SBM #0

FIG. 5

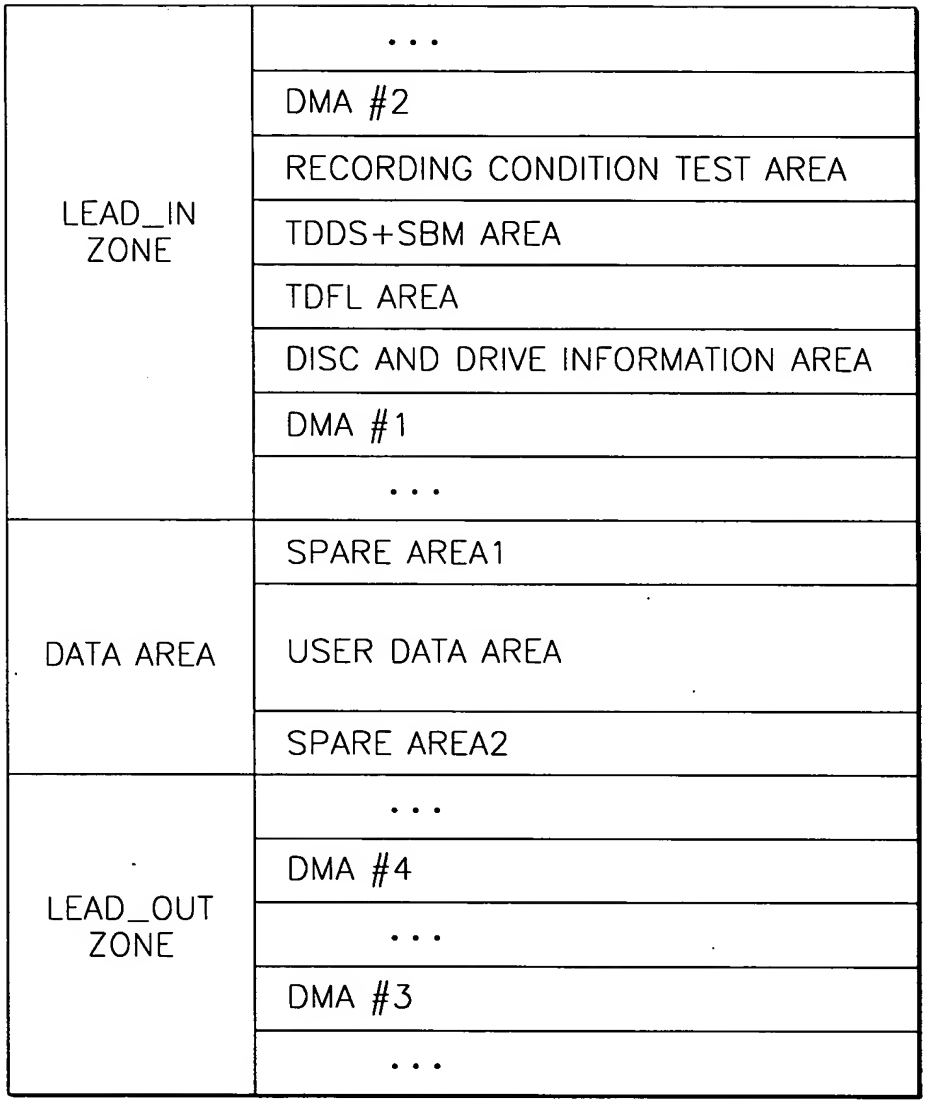

LEAD_IN ZONE
...
DMA #2
RECORDING CONDITION TEST AREA
TDDS+SBM AREA
TDFL AREA
DISC AND DRIVE INFORMATION AREA
DMA #1
...
DATA AREA
SPARE AREA1
USER DATA AREA
SPARE AREA2
LEAD_OUT ZONE
...
DMA #4
...
DMA #3
...

FIG. 6

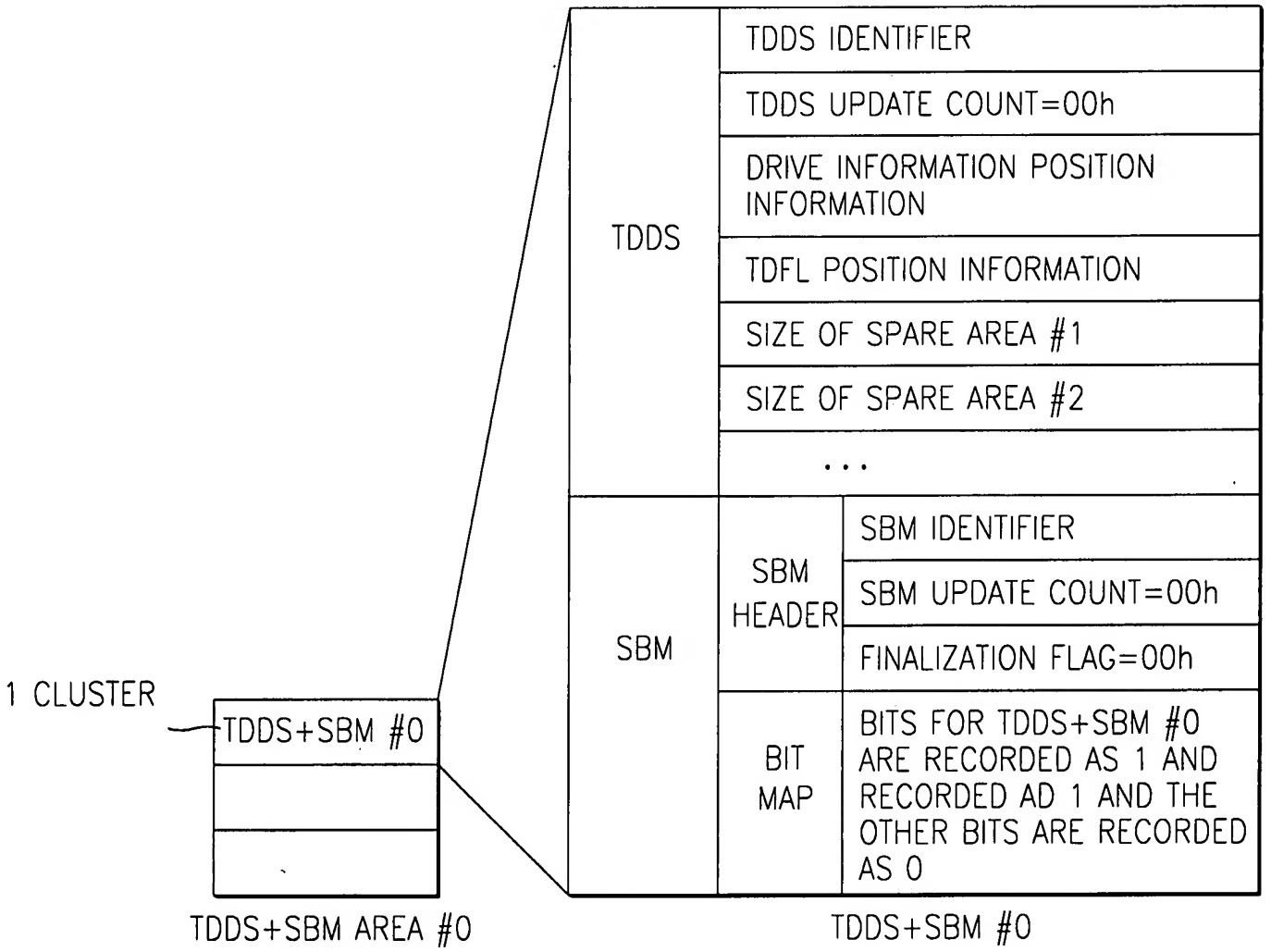

1 CLUSTER
TDDS+SBM #0
TDDS+SBM AREA #0
TDDS
TDDS IDENTIFIER
TDDS UPDATE COUNT=00h
DRIVE INFORMATION POSITION INFORMATION
TDFL POSITION INFORMATION
SIZE OF SPARE AREA #1
SIZE OF SPARE AREA #2
...
SBM
SBM HEADER
SBM IDENTIFIER
SBM UPDATE COUNT=00h
FINALIZATION FLAG=00h
BIT MAP
BITS FOR TDDS+SBM #0 ARE RECORDED AS 1 AND RECORDED AD 1 AND THE OTHER BITS ARE RECORDED AS 0
TDDS+SBM #0

FIG. 7

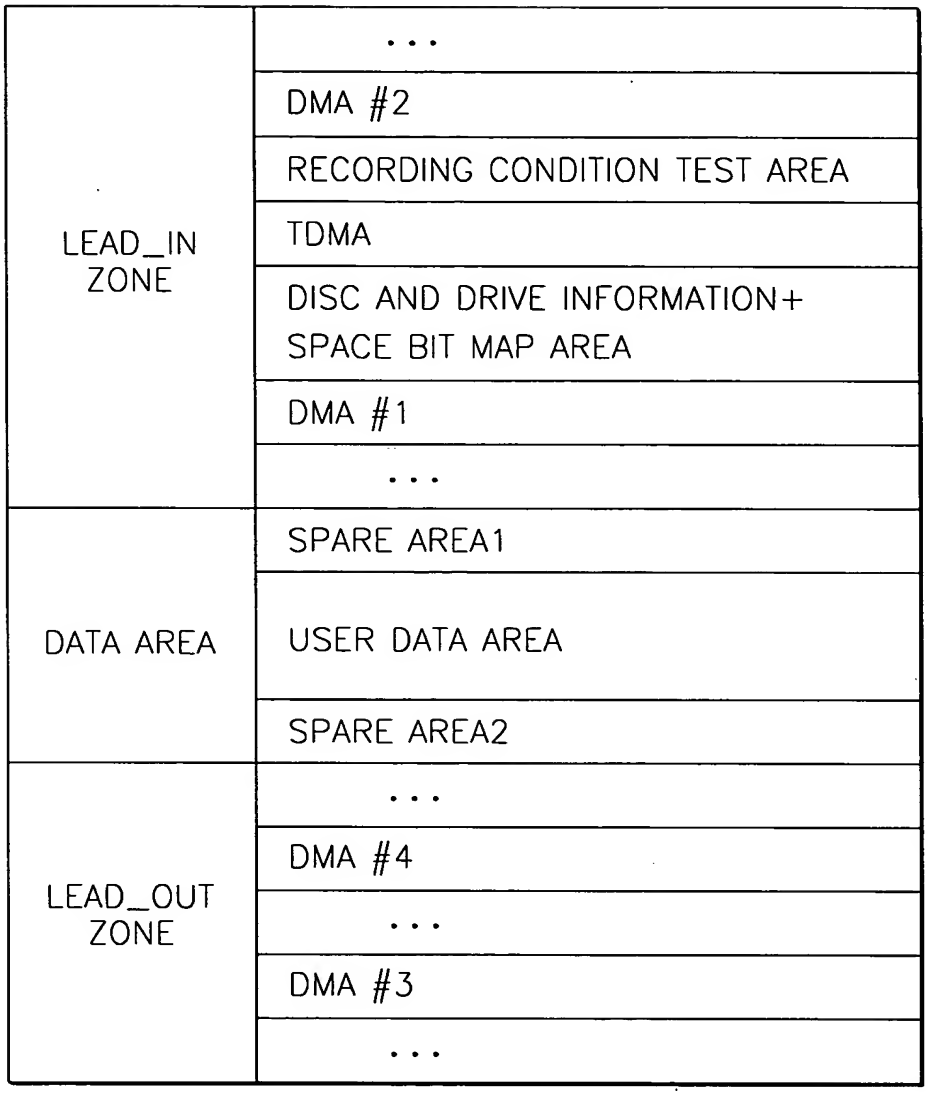

LEAD_IN ZONE
...
DMA #2
RECORDING CONDITION TEST AREA
TDMA
DISC AND DRIVE INFORMATION+ SPACE BIT MAP AREA
DMA #1
...
DATA AREA
SPARE AREA1
USER DATA AREA
SPARE AREA2
LEAD_OUT ZONE
...
DMA #4
...
DMA #3
...

FIG. 8

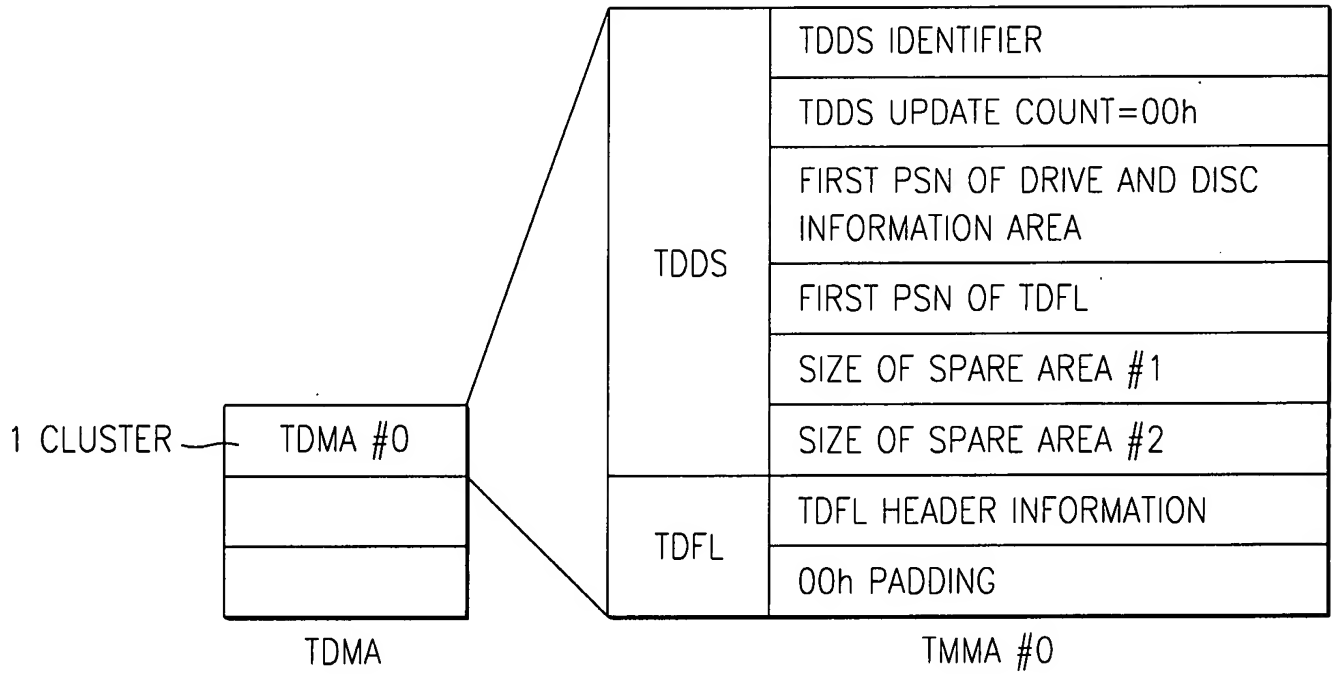

1 CLUSTER
TDMA #0
TDMA
TDDS
TDDS IDENTIFIER
TDDS UPDATE COUNT=00h
FIRST PSN OF DRIVE AND DISC INFORMATION AREA
FIRST PSN OF TDFL
SIZE OF SPARE AREA #1
SIZE OF SPARE AREA #2
TDFL
TDFL HEADER INFORMATION
00h PADDING
TMMA #0

FIG. 9

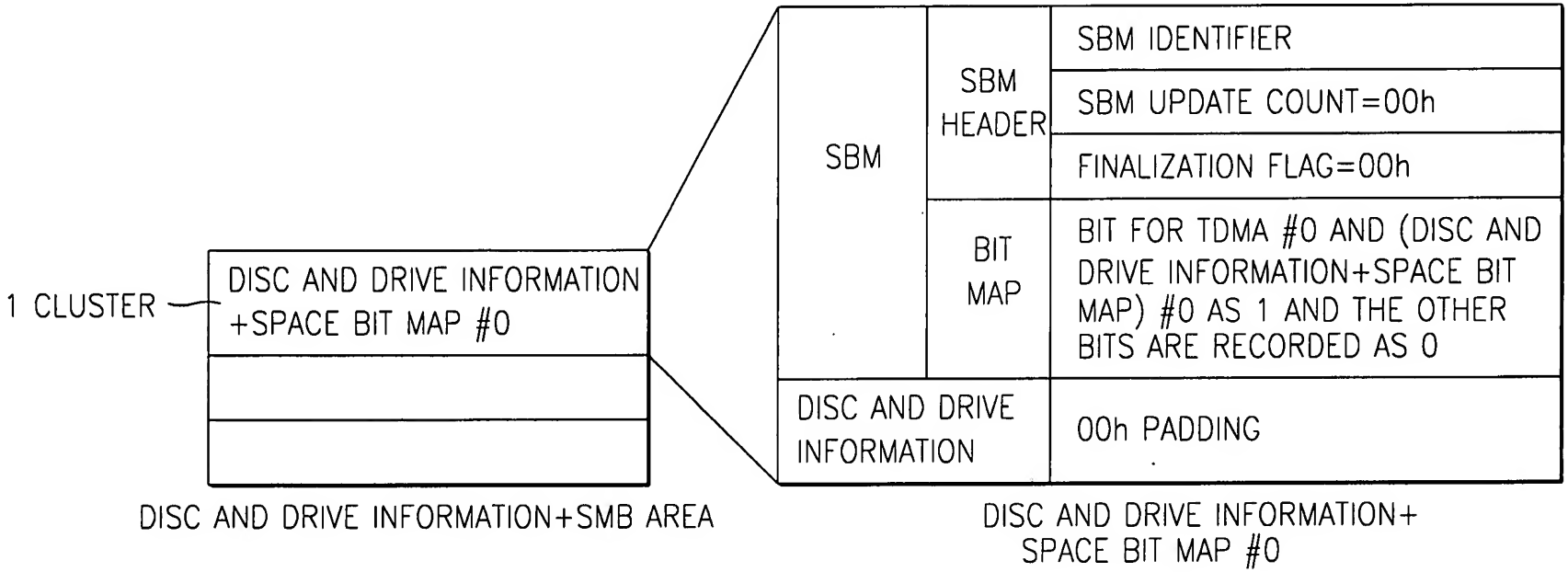

1 CLUSTER
DISC AND DRIVE INFORMATION +SPACE BIT MAP #0
DISC AND DRIVE INFORMATION+SMB AREA
SBM
SBM HEADER
SBM IDENTIFIER
SBM UPDATE COUNT=00h
FINALIZATION FLAG=00h
BIT MAP
BIT FOR TDMA #0 AND (DISC AND DRIVE INFORMATION+SPACE BIT MAP) #0 AS 1 AND THE OTHER BITS ARE RECORDED AS 0
DISC AND DRIVE INFORMATION
00h PADDING
DISC AND DRIVE INFORMATION+ SPACE BIT MAP #0

FIG. 10

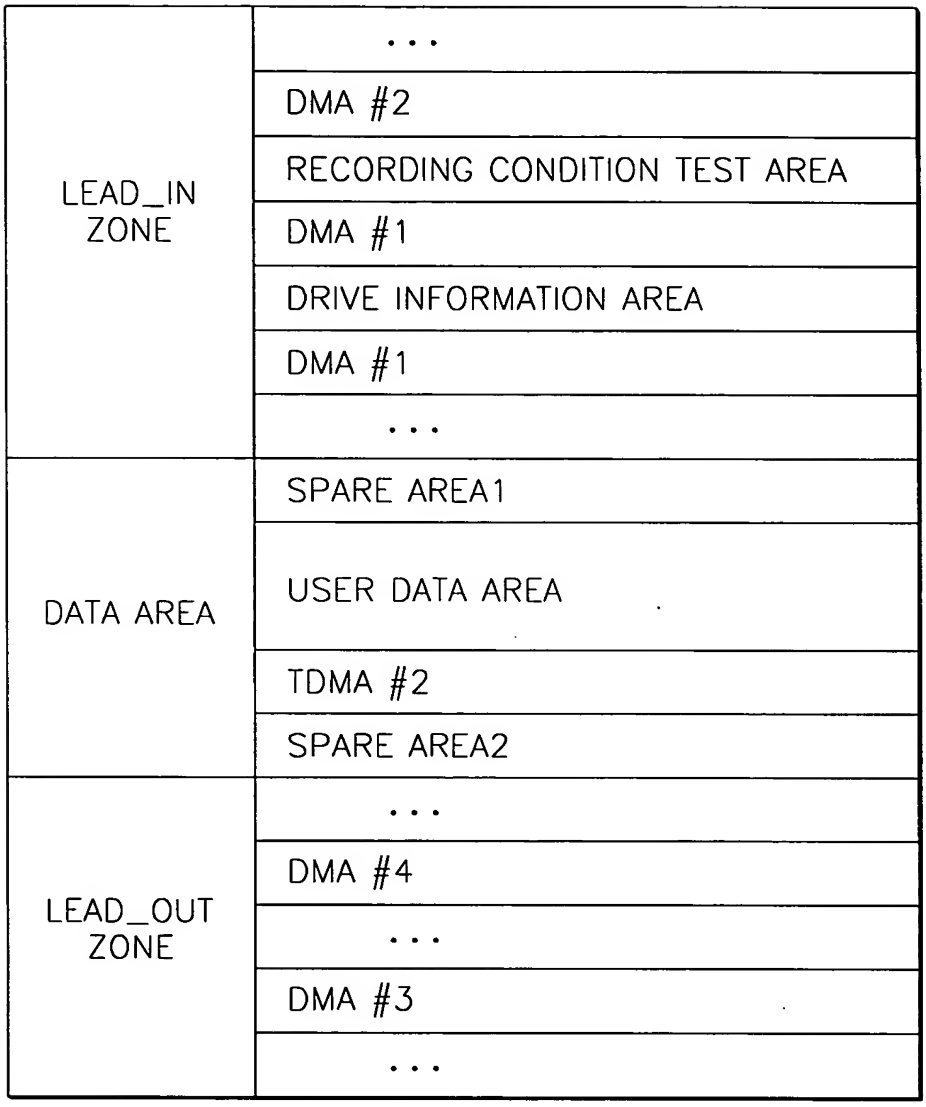
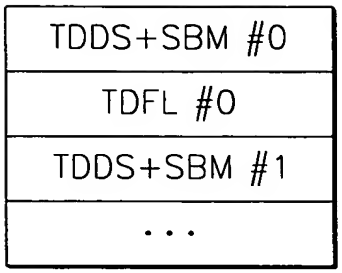

LEAD_IN ZONE
...
DMA #2
RECORDING CONDITION TEST AREA
DMA #1
DRIVE INFORMATION AREA
DMA #1
...
DATA AREA
SPARE AREA1
USER DATA AREA
TDMA #2
SPARE AREA2
LEAD_OUT ZONE
...
DMA #4
...
DMA #3
...

FIG. 11



TDMA #1

FIG. 12

TDDS	TDDS IDENTIFIER	
	TDDS UPDATE COUNT	
	DRIVE INFORMATION POSITION INFORMATION	
	TDFL POSITION INFORMATION	
	RECORDING DONDITION TESTABLE POSITION INFORMATION	
	POSITION INFORMATION REGARDING TDDS+ SBM AREA FOR ANOTHER RECORD LAYER	
	POSITION INFORMATION REGARDING TDDS+ SBM IN ANOTHER TDMA	
	SIZE OF TDMA #2	
	SIZE OF SPARE AREA #1	
	SIZE OF SPARE AREA #2	
	...	
SBM	SBM HEADER	SBM IDENTIFIER
		SBM UPDATE COUNT
		FINALIZATION FLAG
	BIT MAP	...

FIG. 13

<table>
<tr><td rowspan="10">TDDS</td><td colspan="2">TDDS IDENTIFIER</td></tr>
<tr><td colspan="2">TDDS UPDATE COUNT=00h</td></tr>
<tr><td colspan="2">POSITION INFORMATION REGARDING DRIVE INFORMATION</td></tr>
<tr><td colspan="2">TDFL POSITION INFORMATION=00h</td></tr>
<tr><td colspan="2">RECORDING CONDITION TESTABLE POSITION INFORMATION</td></tr>
<tr><td colspan="2">POSITION INFORMATION REGARDING TDDS+ SBM IN ANOTHER RECORD LAYER=00h</td></tr>
<tr><td colspan="2">POSITION INFORMATION REGARDING TDDS+ SBM IN ANOTHER TDMA=00h</td></tr>
<tr><td colspan="2">SIZE OF TDMA #2</td></tr>
<tr><td colspan="2">SIZE OF SPARE AREA #1</td></tr>
<tr><td colspan="2">SIZE OF SPARE AREA #2</td></tr>
<tr><td rowspan="4">SBM</td><td rowspan="3">SBM HEADER</td><td>SBM IDENTIFIER</td></tr>
<tr><td>SBM UPDATE COUNT=00h</td></tr>
<tr><td>FINALIZATION FLAG=0</td></tr>
<tr><td>BIT MAP</td><td>...</td></tr>
</table>

FIG. 14

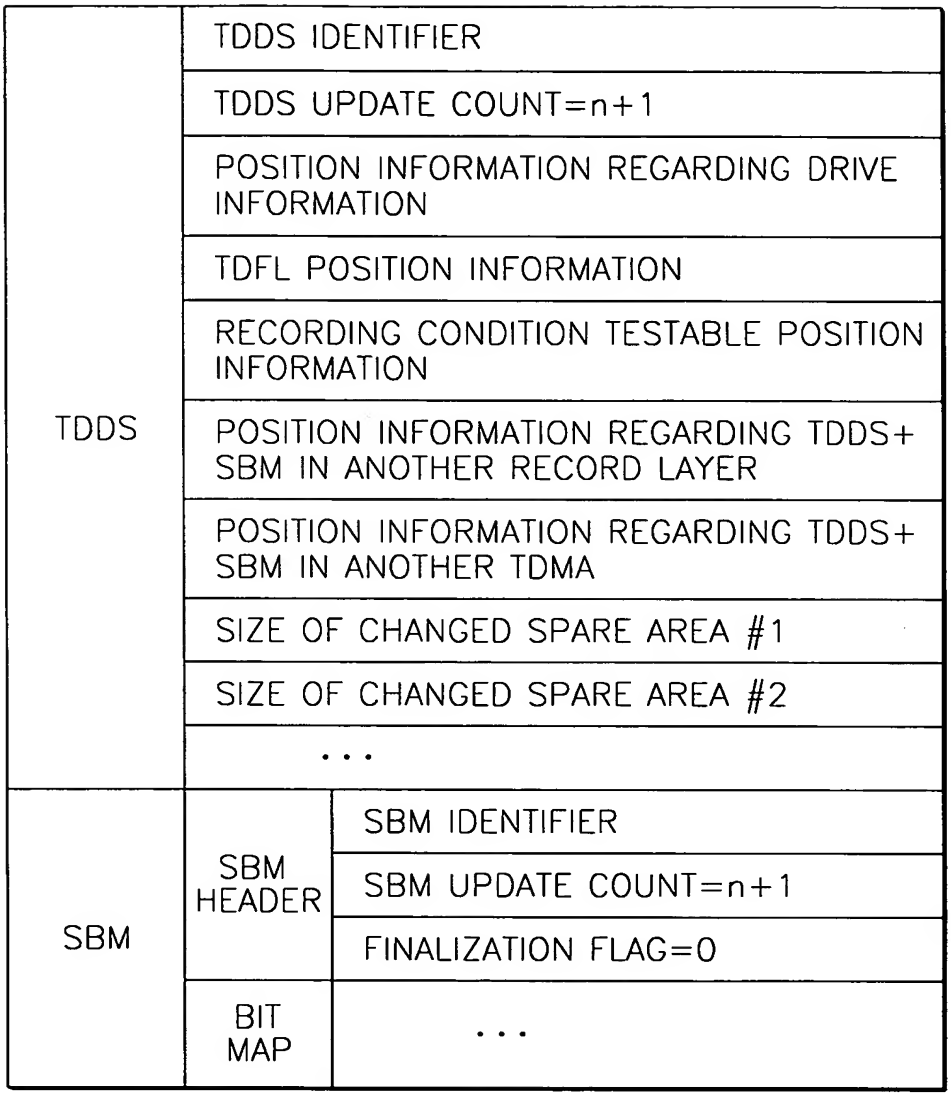

TDDS
TDDS IDENTIFIER
TDDS UPDATE COUNT=n+1
POSITION INFORMATION REGARDING DRIVE INFORMATION
TDFL POSITION INFORMATION
RECORDING CONDITION TESTABLE POSITION INFORMATION
POSITION INFORMATION REGARDING TDDS+ SBM IN ANOTHER RECORD LAYER
POSITION INFORMATION REGARDING TDDS+ SBM IN ANOTHER TDMA
SIZE OF CHANGED SPARE AREA #1
SIZE OF CHANGED SPARE AREA #2
. . .
SBM
SBM HEADER
SBM IDENTIFIER
SBM UPDATE COUNT=n+1
FINALIZATION FLAG=0
BIT MAP
. . .

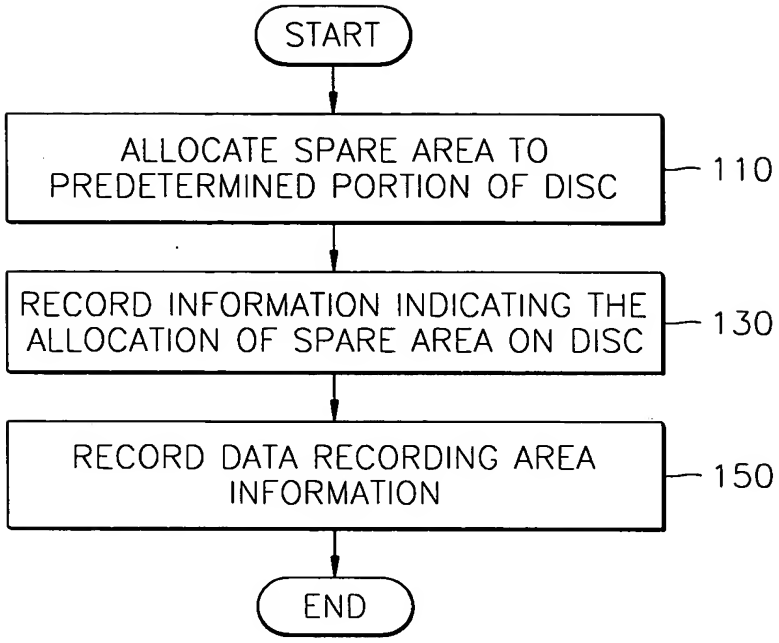
FIG. 15

SBM #0	FINALIZATION FLAG=0
	UPDATE COUNTER=0
	BIT MAP #0
SBM #1	FINALIZATION FLAG=0
	UPDATE COUNTER=1
	BIT MAP #1
...	...
SBM #n	FINALIZATION FLAG=0
	UPDATE COUNTER=n
	BIT MAP #n
...	...

FIG. 16

SBM #0	FINALIZATION FLAG=0
	UPDATE COUNTER=0
	BIT MAP #0
SBM #1	FINALIZATION FLAG=0
	UPDATE COUNTER=1
	BIT MAP #1
...	...
SBM #n	FINALIZATION FLAG=0
	UPDATE COUNTER=n
	BIT MAP #n
SBM #n	FINALIZATION FLAG=1
	UPDATE COUNTER=n
	BIT MAP #n
NON-RECORDING AREA	ffh
...	...

FIG. 17


START
ALLOCATE SPARE AREA TO PREDETERMINED PORTION OF DISC
110
RECORD INFORMATION INDICATING THE ALLOCATION OF SPARE AREA ON DISC
130
RECORD DATA RECORDING AREA INFORMATION
150
END